# *Nature's Net Positive*

Christian Schmoll
Undergraduate Thesis
College of Architecture and Planning
Ball State University
Studio Professor - Professor Robert J. Koester
Thesis Adviser - Professor Joshua Coggeshall
Project Location - Bargersville Indiana

Image 1: "Sunshine Forest" taken by Henrik Spranz for The Light Through The Trees Photo Contest.

Nature's Net Positive seeks to explore net zero energy performance, the experience of day light and sunlight, and the importance of contrasting 'cave-like' interior spaces. A review of the lighting of the past has guided this project. Light provides numerous benefits, but in our desire for privacy, we tend to close off from natural light in our homes. This thesis will explore a means to enhance light while affording residents the privacy they seek.

Daylighting can contribute to the architectural experience at three scales: site, building, and room. The light experiences in this project are inspired by the many varying lighting experiences nature provides, such as how light interacts with trees and caves. Nature's Net Positive seeks to explore light at the site, building, and room scales to demonstrate how this form of community can harness natural sunlight and use it to enhance the overall experience. Nature's Net Positive is a small housing community project based in Bargersville, IN. This thesis focuses on the patterns and character of walkability throughout the site, emphasizing unit spacing and placement and integration of vegetation to create varying light and dark zones of daylight exposure. A south orientation focus will be utilized to maximize sunlight exposure and management within the homes. A double skin system will be used to collect and disperse sunlight into the homes in a manner similar to trees letting the light peek through while providing shade and cover. Thesis explorations have produced a set of systems which build on one another creating cohesion throughout the site.

This gives life to the project and furthers the goals of net positive energy, water, and heat. The site itself becomes a carbon sink that creates the light and dark spaces on the site. There is a focus on the harvesting of electrical energy from daylight within each home and the use of raingardens to collect water on site.

Nature's Net Positive is not a conventional suburban neighborhood. The layout of the site follows the form of the buildings to create a community that blends together and enhances the resident experience. It consists of 135 homes, a community building, and a farmer's market. The homes on the site vary from one-bedroom, one-story homes to four-bedroom, two-story homes. The one-story homes enable small families and the elderly to have a comfortable, easy to manage living space, while the two-story homes provide ample space for large families or those wishing to have room for growth. The community building will be a multi-purpose facility. It will be a gathering place for residents and include a technology lab and game center. It will provide the community with various rental options including car, bike, scooter, and kart to navigate throughout the site. There will be offices within the community center and staff to assist residents with their needs and ensure they are aware of services available within the community building. The farmer's market is an important aspect to the project as it calls back to the rich farming history of the surrounding area. Much of the surrounding land remains farmland despite the housing communities growing across the area. The farmer's market will enable farmers to sell their goods locally to the community.

## Issues and Positions

Nature's Net Positive seeks to find net zero solutions to lighting for homes in a small rural community. In traditional homes, privacy concerns often lead to closing off of natural daylight. This thesis explores ideas which allow for privacy while harnessing sunlight as a main source of light. The use of sunlight in this manner will lower overall energy consumption. Limitations noted with past net positive solutions include a focus on the creation of adequate energy to meet consumption without lowering overall consumption. This thesis seeks to create energy while at the same time lowering overall energy consumption so that net positive energy can be achieved.

A limitation to traditional sun lighting in homes is glare which often leads residents to close off windows thereby necessitating alternate forms of light & energy consumption. A solution to this is the use of the roof as the primary light source. A double skin roof system allows for day lighting to filter in at a diffused level. This solution allows for natural light in the homes that will not be closed off and affords the privacy residents often seek in their homes. Other issues identified relate to the site and climate. The site has a loamy, high lime till soil. This gives the site good compression but poor percolation and water runoff. The solution to counter this is creating spaces for the water to collect and be reused to support the natural elements on site. To achieve this, raingardens have been integrated alongside water collection systems. The raingardens alongside the trees on site create a carbon sink. With over 50% of the site serving as a carbon sink, air pollution is also addressed in this design as well.

Image 2: Poorly lit building from "Accessibility Progress Slow at Queen's."

Image 3: Poorly lit building with blinds closed from "BSF funding should not be cut, says CABE" by Richard Waite.

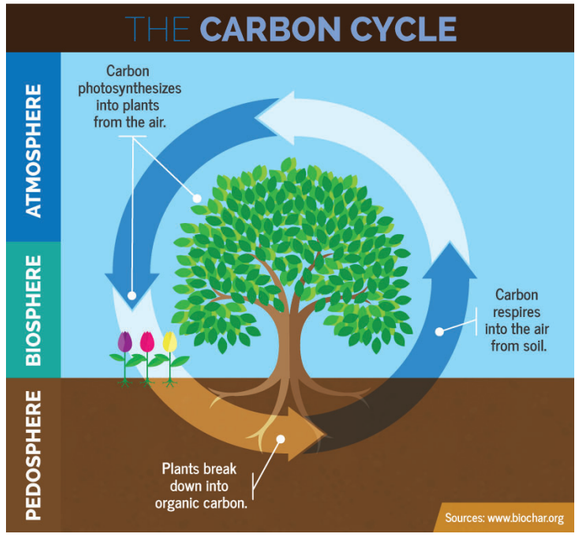



Image 4: The Carbon Cycle from Allie Lowy.



## Design Question, Thesis, and Project Summary

Nature's Net Positive asks the question, "Can daylighting contribute to net zero energy performance?" This thesis explores how lighting experiences can benefit the building in more ways than simply using light as an experience. Nature's Net Positive seeks to find the appropriate level of foot-candles for optimal experience, using light and darkness to create different spaces and enhance the lighting experience. For this thesis, the dark spaces are private, and the light spaces are the public domains.

Daylighting contributes to the architectural experience at three scales: site, building, and room. Nature's Net Positive explores these lighting experiences through examples found in nature. The natural elements used as an experiential inspiration are light coming through trees and cave openings. The project uses trees to control the lighting throughout the site. There are darker spaces and lighter spaces which utilize the light to create spaces of escape, to invite residents to stop and rest on the site. The buildings, by use of the double skin roof, seek to recreate light coming down from the treetops. In public spaces within the home, the roof alternates between transparent and opaque surfaces so that the light can diffuse and filter down. The bedrooms emulate the cave entrance with a single floor to ceiling window which connects to a wall allowing the light to reach further into the room and reflect off 3 surfaces within the room. These windows are positioned on the northside of the building to prevent overbearing light at sunrise & sunset.

The use of natural elements outside provide privacy for the residents in their bedrooms so that the windows can remain open. The community building will offer services to enhance the resident experience. Various solutions to assist with mobility throughout the site will be offered.

Nature's Net Positive explores these ideas while exploring a unique community. The site promotes walkability rather than driving. Parking runs down the center of the site and is hidden from the homes while walking, and bike paths run throughout the site. This project includes 135 homes, a community building, and a farmer's market. The elements on site work together to create a unique housing community which promotes energy efficiency while combating air pollution.

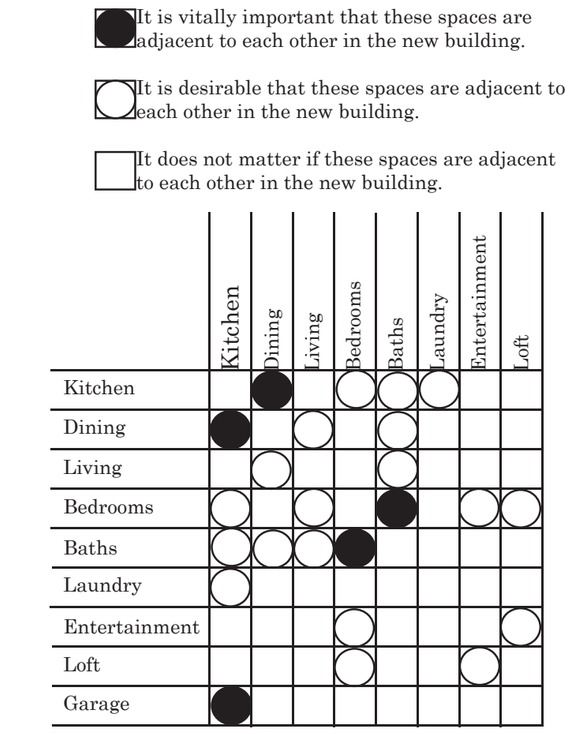
# Programing

Nature's Net Positive is a small community housing project catering to young and old as well as different sized families. The site has 135 homes, a community building, and a farmer's market. The community building and farmer's market will be positioned on the East end of the site along County Rd. 300 W.

**Homes:**
- One-bedroom, one story homes: for small families or elderly.
- Two-bedroom, one story homes: for small families or elderly.
- Two-bedroom, two story homes: for small families.
- Three-bedroom, two story homes: for medium size families.
- Four-bedroom, two story homes: for larger families.

**Community Building:**
- Technolgy lab
- Car rental
- Bike/scooter rental
- Kart rental
- Moving assistance
- Game Center
- Offices/renter's offices
- Raised floor system

**(Outdoor) Famers Market:**
- Open to the public
- Stands for the farming community to set up and sell
- Parking provided on the East of the site by resident parking



Housing Matrix Diagram



# Site Context: Physical and Cultural

Nature's Net Positive, in order to create a sense of community living, needs to remain small enough to foster community while being large enough to accommodate 135 housing units. For this purpose, a site along County Rd 300 W in Bargersville, IN was chosen. The site is surrounded by farms and other small housing communities. This site was chosen after analyzing a second site North of the current location. The site was chosen based on its size and good open space. There is also only one small home currently on the site making it relatively easy to prepare for renovation. Additionally, there is a school directly behind the site making it more desirable for families with children.

The climate zone is Zone 5 which is very common for most of Indiana. The North winds bringing in cold wind during the winter months provide a challenge which will be addressed using trees to block the North winds. The ecosystem on the site is Loamy, High Lime Till Plains. This means the site has a lot of organic content of sand, silt, and clay. As with most of Indiana there is a majority clay which means the site has good compression, but bad percolation and water runoff. This means if the site has a hole or spot where the water can collect it will puddle up more creating some issues. There is also a lot of lime under the soil of the site and it is in a plain, so it is flatter which makes sense seeing as the whole area used to be farmlands before homes started to move into the area.

The site is South of Indianapolis and County Road 300 West turns into Meridian or State Road 135 which leads right to downtown Indianapolis. The purpose for setting the site along this road was so that people living in the community could easily commute to Indianapolis or Greenwood for work. Greenwood is approximately a 10 minute drive to the North while Indianapolis is about a 30 to 35-minute drive.

The majority of the area around the site remains farmland still today. There is a farmer's market South of the site along SR 135 with limited parking which is open on Sunday's only. Commercial and residential growth have been expanding south from Greenwood and have begun replacing many of the old farmlands. Indiana has a rich farming history and this thesis attempts to create something new while embracing this history with the farmer's market.


Image 5: Large Context Map


Image 6: Loamy Soil from Glenda Taylor.

# Site Context: Physical and Cultural

Image 7: Context Map

Image 8:Existing Site



# Site Context: Physical and Cultural


Image 9: Photo of Site by Author


Image 10: Photo of Site by Author


Image 11: Photo of Site by Author

# Research Overview: History of Daylighting

How can light experiences in nature be used in the design of a building to limit energy use, to lower energy required for net zero energy? How can these lighting experiences become useful? What do the darker spaces become and what occurs in these spaces of light? Daylighting is an important feature in all architecture; it has come back into importance for a whole new reason. Daylighting has health benefits that we ignored in the past for efficiency of workers in factories. Looking into the past of architecture before artificial lighting we can start to see examples of proper daylighting and how it can enhace and grow a project.

Daylighting has played an important role in architecture for centuries. From Persia in ancient times to large glass windows in Gothic Architecture.[1] The Native Americans also understood the importance of daylighting and used it in their structures. Lighting and daylighting in architecture has evolved and enhanced the experiences in space throughout architecture. From old times when openings were needed to light a space to candles to the lightbulb. Lighting is an important role that should be explored and expanded to create new experiences. However to grow into the furture we must first look at the past of daylighting to see how it has changed and evolved.

Older buildings before the electrical era in many ways understood the importance of daylighting. Having daylight in the space was the best or only way to light a space in ancient times. Looking back at ancient buildings in Persia, buildings were designed to keep perishable goods cool.[2] This isn't as important now but still an important experience to study with lighting and space in architecture. Old building often showcases unique lighting solutions because there were limited ways to light the space. In ancient Egypt they had good amounts of daylight and buildings were designed to prevent glare and blinding sunlight with minimized openings in the roof and walls.[3] Some of their strategies were small openings with deep walls to diffuses the light into the space. Clearstories were also used to allow for deep plans to enhance the daylighting to the interior. In Ancient Greece activities were done outdoors and buildings were objects to be viewed more than they were to be inhabited. The daylighting was a minor importance for lighting the whole of the space but rather used to light specific areas or sculptures in the spaces. Such as with the temples, they were orientated to the East to illuminate the statures of their gods through doorways and large roof openings at sunrise. The need to light space with daylighting was more important back druing times without artificial lighting. However, electrical lighting should add to the natural daylight instead of ignoring it as many architects did during the International Style.

1 "Daylighting and Architecture: How Classic Historical Buildings Used Daylighting," Bristolite Daylighting Systems - Leading Skylight Manufacturer in USA, March 12, 2014

2 Daylighting and Architecture: How Classic Historical Buildings Used Daylighting,"

3 Nyole F Chepchumba, 2013,"History of Daylighting Strategies: A Comparative Analysis,"



# Research Overview: History of Daylighting

Before the International Style and the Industrial Revolution the role of daylighting changed. Daylighting was used to light the environment used by the workers for the highest possible levels of productivity. Whereas in the eras before this lighting was used as decoration or to see in a space. Lighting techniques such as windows and skylights were changed from their celebratory use to a utilitarian use. This change did focus more on productivity but the daylighting was still being used in the space. The change of function followed the practices and needs of the people. This is not a bad thing it shows the growth of lighting in the building and gave us more ways to light a space and new ideas for why a space should be lit.

Then with the International Style there was a rise of electrical lighting. During this period there was no need to have natural light because the architects were focusing on large floor plans and using lightbulbs to light the spaces. Ultimately, we saw some issues with lighting artificially with no daylight. For one it creates fire hazard. This was a dangerous period in which we moved away from natural daylighting and into the lightbulb. The lightbulb is a great invention and very useful to architecture, however, it should not steal all the focus away from daylighting. The spaces in International Style buildings feel wrong when you enter them because there are no windows and the space feels more trapped and closed off. Luckly we saw the issues with cutting out daylight as well as the benefits that daylighting brings to a building.

Over the past few decades, daylighting has become more important again. For one big reason it is more energy efficient and lowers the cost of the buildings. There are also health benefits to Sunlight that are received with artificial lighting. Work of architects such as Frank Lloyd Wright, Louis Kahn, Alvar Aalto, and Le Corbusier used the artificial light while also creating lighting experiences in their buildings using unique openings. They Created new lighting experience that celebrate the space again. But now these ideas they introduced are used to create energy efficient building. "The artificially lit workplaces of the 20th century have been slowly replaced with energy efficient design and daylighting."[4] These savings in energy are important to focus on to begin to heal the planet. Focusing on past buildings and how light was used can help to build into new ideas of lighting and create new spaces to better help the planet and clients who inhabit the buildings.

Looking back at building before the age of energy and lightbulbs can show us ways to light a space that will save energy and create a cleaner environment for the building. Daylighting is important and new experiences can only add to the argument for daylighting to show the benefits and experiences it can create in more sustainable building. Therefor, this thesis will explore the control of natural daylighting to enhace the spaces through sustainable systems.

4 Nyole F Chepchumba

# Research Overview: Architectural Precedents

Image 12: Exterior View of 25 Verde: Corten Forest

25 Verde: Corten Forest was one of the first architectural studies done for this thesis. Nature's Net Positive explores light in building based off natural elements. 25 Verde: Corten Forest was a good example to this idea. Using real plants to create the shadows and light illuminating into the building. Ultimatley this study lead to ideas that are explored in this thesis. 25 Verde is an escape to nature in a city scape and that is an idea that was explored a lot during this thesis. 25 Verde has interesting lighting expirences that occur through the entire building. This also helped to develope ideas with orientation and how to capture the light.

Image 13: Front exterior of Torr Kaelan: Synergy and Sustainabilty.

Torr Kaelan: Synergy and Sustainability was also an early study done for this thesis. Synergy and Sustainability is a good example of sustainable building. There was also the subtration of a cube, which lead to the form that was ultimatley decided upon for this thesis. The way light is used in Synergy and Sustainability was an interest that helped to further light experiences and design for Nature's Net Positive.



# Research Overview: Architectural Precedents

Image 14: Richard Levine: Raven Run

Richard Levine's Raven Run lead to the first main breakthrough in Nature's Net Positive. Raven Run was the inspiration for the form chosen for the homes. This thesis needed to maximize roof lighting in order to achieve the goals set for this thesis. The cutting away from the cube lead to the subtraction done in this thesis. This allowed the project to maximize sunlight during the day not only for light but also for energy production.

Image 15: MOS: House #5: Element House

The form by itself was difficult to make into a home on its own. This lead to the study of House #5: Element House. The clusters went through serveral studies before the final product was desided on. Ultimitley through these studies a system was created using the form that could follow through on every aspect of this thesis.

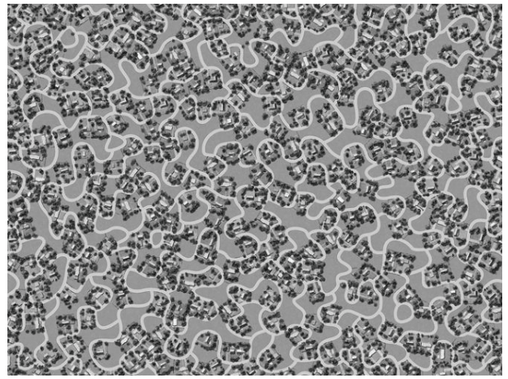


Image 16: Ross Racine: Landscape Design

The site was inspired by an ordered system that feels disordered. There is an overarching idea that has elements and pieces that break this pattern but still fit into the overall set of systems for this design thesis.

# Research Overview: Early Design Strategies for Site


Riverside Manor
Maple St
Maple St
Maple St

# Research Overview: Systems

This thesis has an importance on the use of passive systems at the building scale and taking those ideas into the community as a combined set of systems to grow the project and achieve the goals. HVAC is radiant floor systems with a double skin chimney to collect, store, and release heat. The roof system was designed based off the form of the buildings alongside the idea of a double skin system. This site also collects water and uses it to water the site and is stored and used mainly in the rain gardens. This helps to solve issues on site with water puddling. The site has bad water runoff so controlling the water and collecting it is important in the overall success of this thesis.

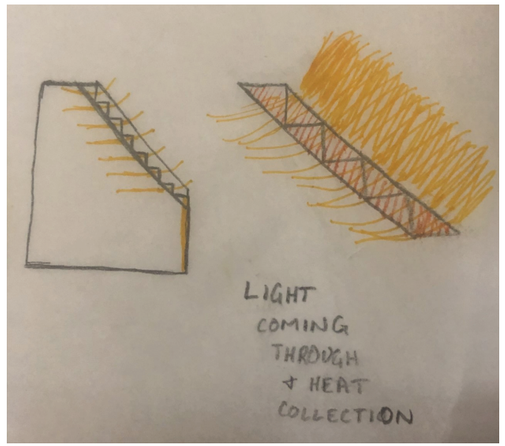



Image 29: Sketch of double skin roof for heat collection by author

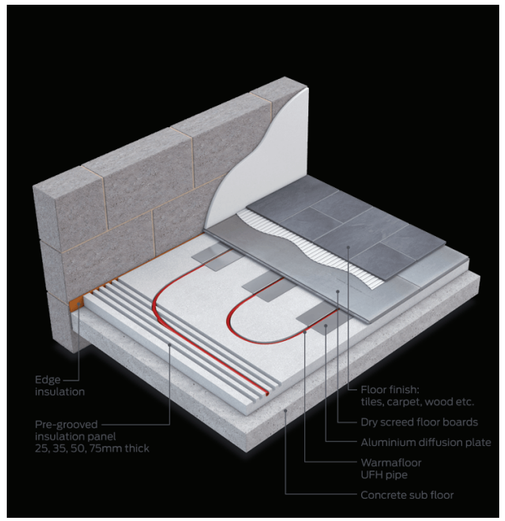



Image 30: "Underfloor Heating and Cooling Systems." by Warmafloor.


Image 31: Photo of water collection vs a water collection system from "Rainwater Harvesting Systems vs Rain Barrels - Chicagoland & Kane County Illinois (IL)."


Image 32: RainXchange™ Rainwater Harvest System from "Rainwater Harvesting Systems vs Rain Barrels - Chicagoland & Kane County Illinois (IL)."



# Nature's Net Positive: Design Thesis

**Design Question:**

Can daylighting contribute to net zero energy performance? How can these lighting experiences become useful to the building instead of using light for the sake of having a lighting experience? What do the dark spaces become and what occurs in these spaces of light? Nature's Net Positive Seeks to explore these ideas.

**Thesis:**

Daylighting can contribute to the architectural experience at three scales: site, building, and room. These light experiences are inspired by different lighting experiences in nature. Such as how light interacts with trees and caves.

Nature's Net Positive is a small community project with the goal of achieve net positive energy while lowering overall energy cost through use of daylighting. The daylighting systems used are passive systems set to lower the amount of energy needed to live in the space. Each space in the homes has appropriate lighting levels during sunny days without the use of electrical lighting. In order to examine the results of this thesis existing communities will be looked at and compared to energy production as well as energy consumption. This comparison will show the difference between the proposed ideals as well as low end productions and consumptions for the homes.

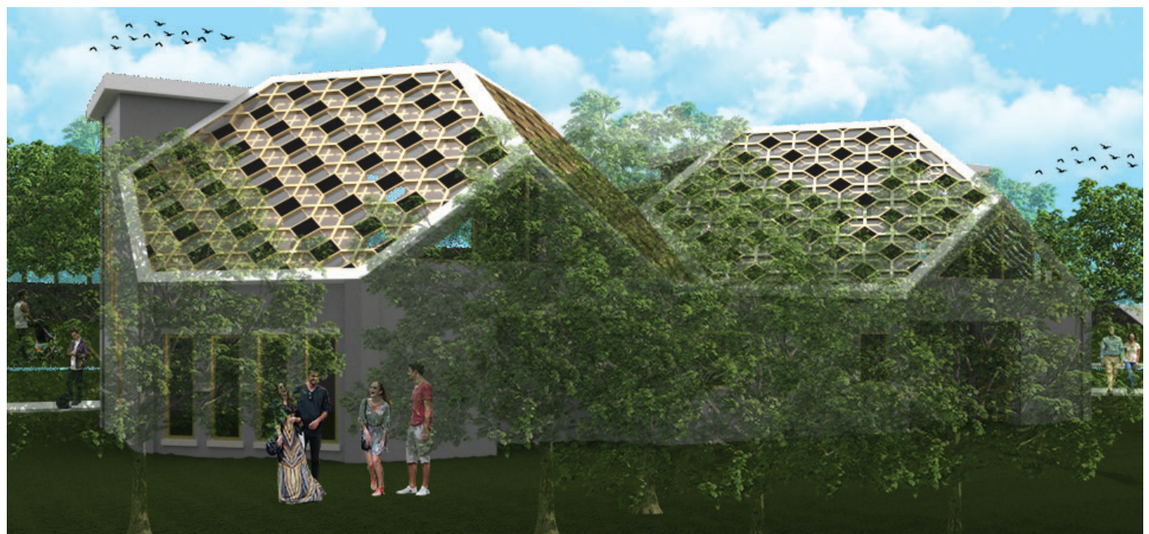


Image 33: Exterior render by author.

# Nature's Net Positive: Design Thesis

## Design Project

Nature's Net Positive is a small community housing project which focuses on different sized families. The site has 135 homes, a community building, and farmers market. The community building and farmer's market will be placed on the East of the site along County Rd. 300 W.

Homes:
- One-bedroom, one story homes: for small families or elderly.
- Two-bedroom, one story homes: for small families or elderly.
- Two-bedroom, two story homes: for small families.
- Three-bedroom, two story homes: for medium size families.
- Four-bedroom, two story homes: for larger families.

Community Building:
- Technology lab
- Car rental
- Bike/scooter rental
- Kart rental
- Moving assistance
- Game Center
- Offices/renter's offices
- Raised floor system

(Outdoor) Famers Market:
- Open to the public
- Stands for the farming community to set up and sell
- Parking provided on the East of the site by resident parking

## Problem Identification

The main problem is that buildings do not interact with sunlight enough and most homeowners close off their windows. This thesis will also seek to create lighting situations that illuminate the spaces while providing privacy. This thesis will also address shade as a light experience and explore light and dark and how the two can interact.



# Nature's Net Positive: Design Thesis

The setting evaluation for Nature's Net positive is to create a net positive solution to a housing community that is beautiful in nature and controlled by walking and biking paths. This solution should also focus on solar collection for energy and to light areas of the homes.

- Dark and light spaces: Mini forest to explore and open green spaces for rest
- Rain Gardens to help with water collection on site
- Solar panels on every home to create energy for the site.
- Walking/Biking paths to explore the public spaces on site.
- Trees around site to provide a carbon sink for the site.
- Solar covers over the parking to create more energy and shade the cars.

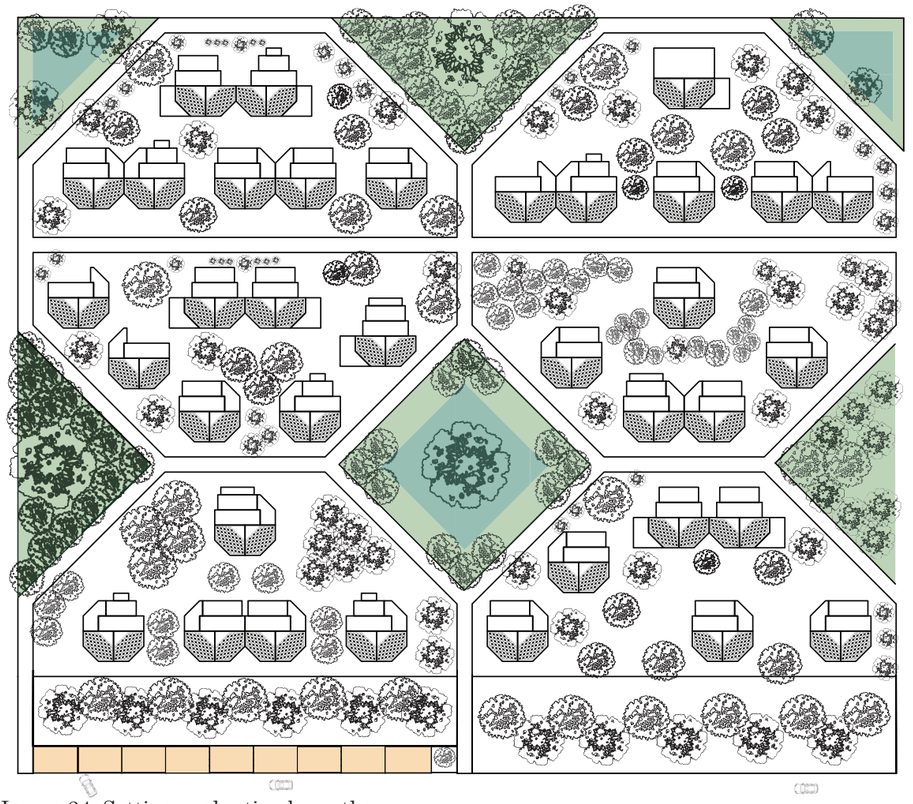


Image 34: Setting evaluation by author.

# Nature's Net Positive: Design Thesis

To analyze the solution multiple architectural precedents were studied and explored as a set of systems working together. Each idea was explored multiple times to find the best solution to the goals of this thesis. The studies were each inspired by precedents and pushed through variations to find the best outcome in terms of layout and lighting. Each study worked together as a set of systems to achieve appropriate lighting levels and energy production.

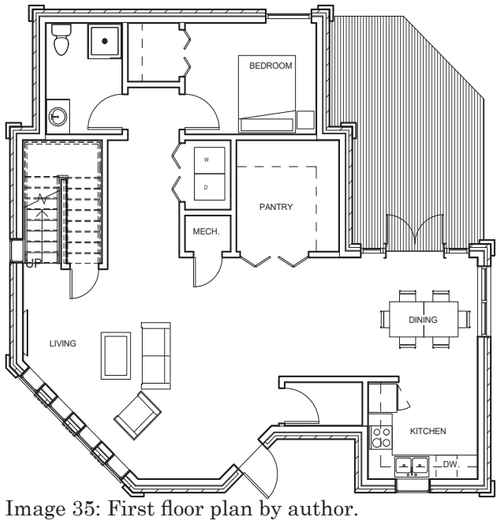



Image 35: First floor plan by author.

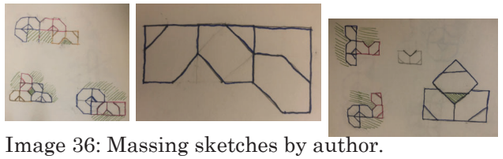


Image 36: Massing sketches by author.

The original massing was the whole building. Then I started looking at how they could cluster into a better building form.

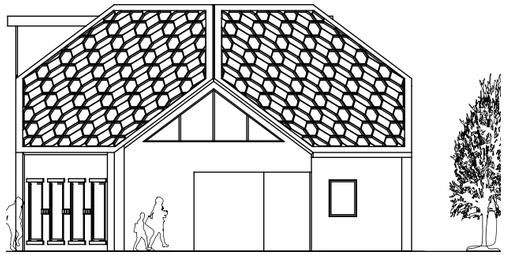


Image 37: South elevation by author.

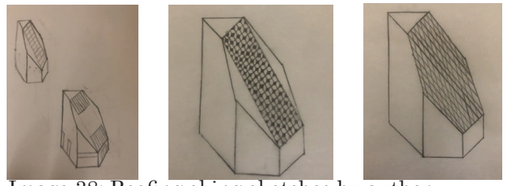


Image 38: Roofing sking sketches by author.

The roof skin was explored in multiple options to find an appropriate lighting mood for the public spaces of the homes. The design on the roof was settled upon after looking at the housing cluster. The roof skin is four of the original form squared up together.



Image 39: Site plan by author.

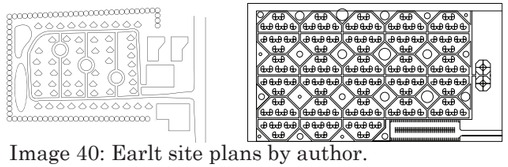


Image 40: Earlt site plans by author.

The site was original explored as a study on an existing site to the north of the selected site. This thesis however is not a normal suburban neighborhood so a new form that focuses more on walking was explored. However, the parking was just on the site, so the site was reworked to hide the parking and moved to the middle of the site so that all the houses had closer parking options.



Nature's Net Positive: Design Thesis

This thesis looked to three main projects for inspiration of the set of systems that come together. The form came from looking at Richard Levine's Raven Run, massing ideas came from MOS: House #5: Element House, and the site came from looking at Ross Racine's Landscape Designs. The set of systems used in the massing skin and site all follow the same form and pattern. The pattern is a cluster of the original form decided upon for Nature's Net Positive. Looking at the form from a bird's eye view shows a pattern created when grouping the modules. This pattern was then added to the roof as a double skin system and to the site and paths.

Image 41: Richard Levine: Raven Run

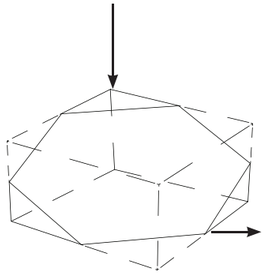


Image 42: Subtraction of a cube by author.

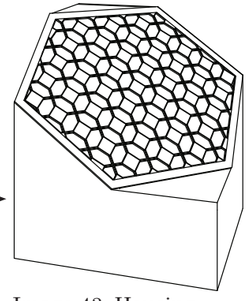


Image 43: Housing Module by author.

Image 44: MOS: House #5: Element House

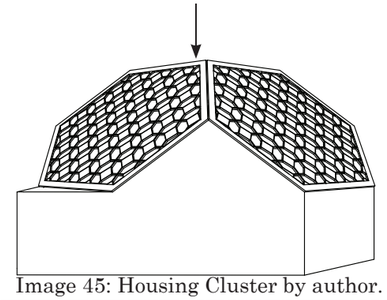


Image 45: Housing Cluster by author.

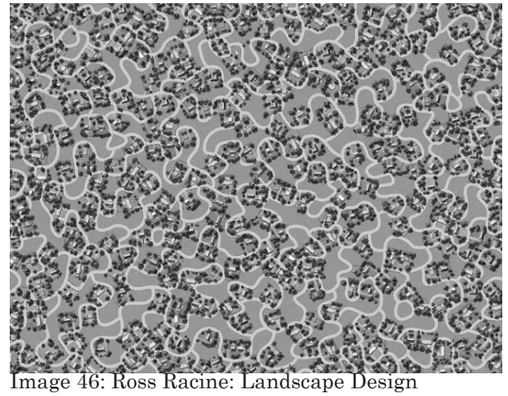


Image 46: Ross Racine: Landscape Design

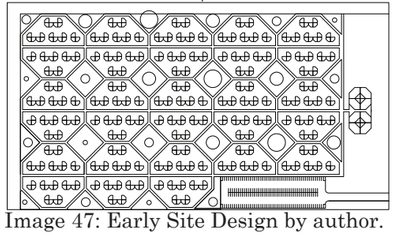


Image 47: Early Site Design by author.

# Nature's Net Positive: Design Thesis

This thesis explores light at 3 different scales. The lighting on the site is explored through darker and lighter spaces throughout the site. The site shows how light interacts with the trees with dense and less dense areas of trees. Building light is experienced through the South facing roof. The roof skin was inspired by light shining through treetops. The room lighting is experienced like a cave opening with glass extending from floor to ceiling along a wall.

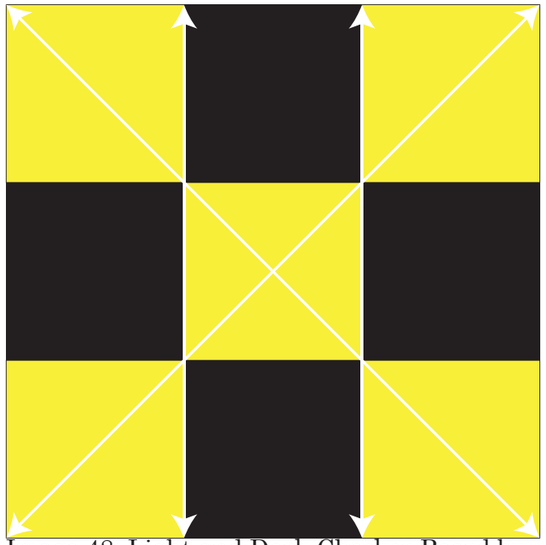


Image 48: Light and Dark Checker Board by author.

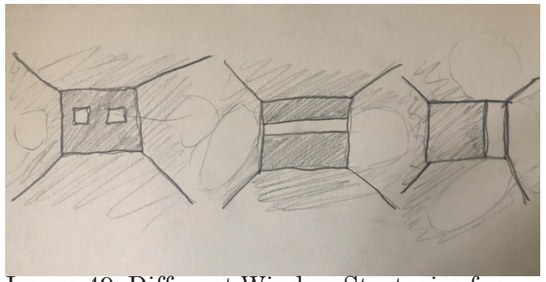


Image 49: Different Window Strategies for Rooms by author.

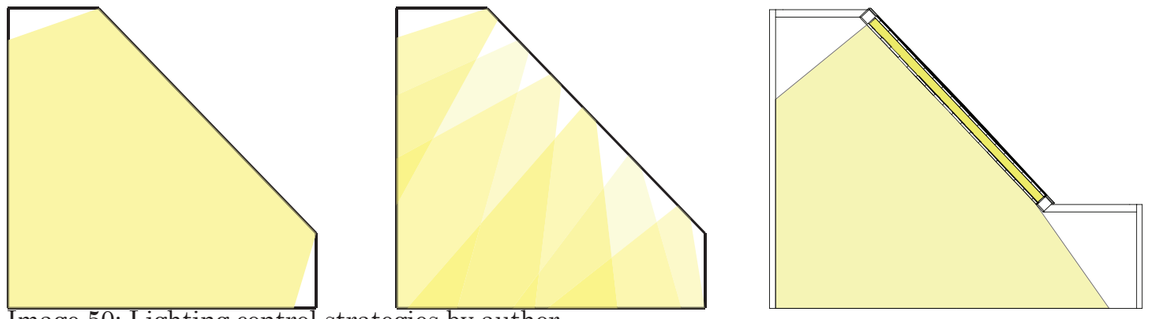


Image 50: Lighting control strategies by author.



# Nature's Net Positive: Design Thesis

Nature's Net Positive is in Bargersville, IN at the corner of County Road 300 West and West Whiteland Road. The plot of land currently has one home surrounded by farmland. Residential properties have been moving south along County Road 300 West. This site was chosen because it sits along a main road that leads straight through both Greenwood and Indianapolis. County Road 300 West is also known as State road 135 and Meridian Street. This area is a growing area with more businesses and homeowners moving out to this area. The site is also open so there is less demolition required to renovate the site with parking and sidewalks. The dirt dug up can also be used to control the water into the raingardens.

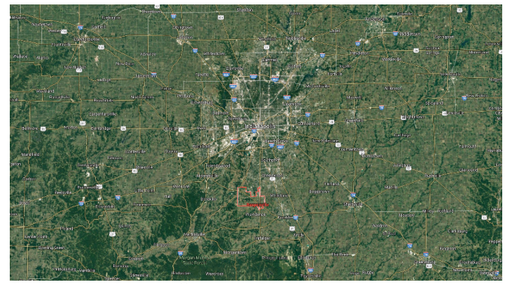


Image 51: Large Context Map

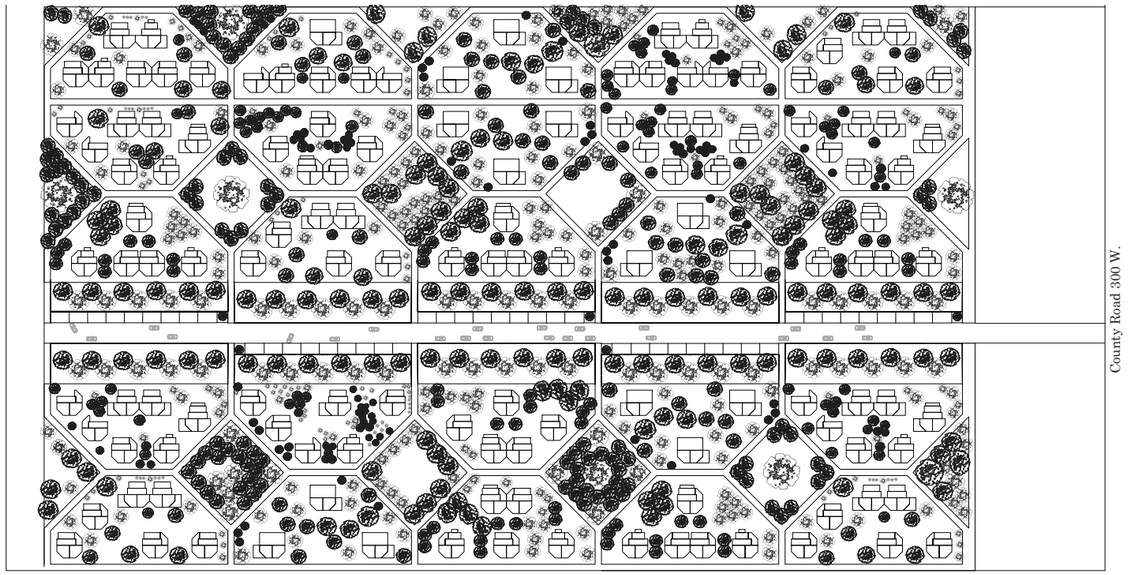

Image 52: Context Map


Image 53: Existing Site

# Nature's Net Positive: Design Thesis

The site layout was designed as a system based off a slight altercation of the building massing grouped together. Movement through the site is controlled by the walking and biking paths rather than roads. The parking runs through the center of the site and is hidden from the homes. The walking and biking paths lead to the homes, mini forests, and raingardens. There are also spaces for people to stop and rest along the walking and biking paths. The homes are all orientated to the south. The East side of the site is where the community center and farmer's market are located. There are 135 homes on site which all enter off the sidewalks. The yard space for the homes is shared for the most part but each home has 30'x30' of space that is private.

The mini forest and raingardens provide a space of rest as well as exploration. There are walking paths that run through the nature zones. The nature zones help to create a carbon sink on site. This was important to the project because it also allows for lighting experiences through the site and create the checkerboard lighting design.

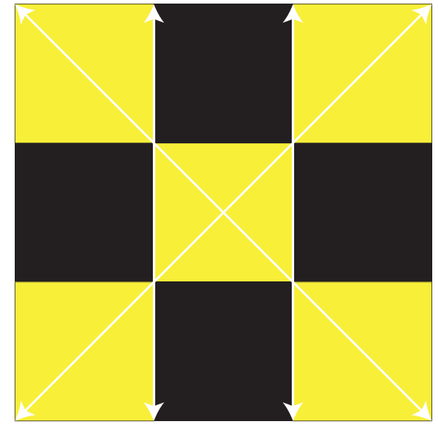


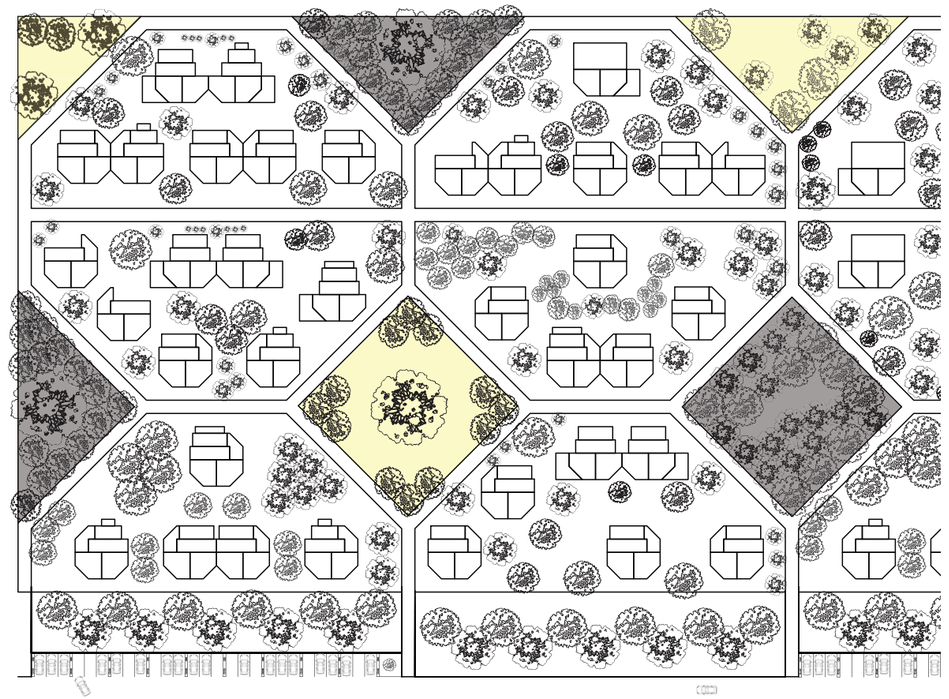

Proposed Site Plan



Nature's Net Positive: Design Thesis

The site has moments of light and dark green spaces. Some of the green spaces are a dark mini forest while others are light park spaces. There are also darker spaces made by clustering the trees by the homes, however, the spaces are left lighter around the homes to allow for the building and room lighting scales. The green spaces are places to stop and escape into nature. The open spaces will have rain gardens to walk through while the dark mini forest will have paths to walk through and have moments of light breaking into the mini forest. There is also a hidden parking that runs down the center of the site. There are hills and trees that hide the parking from view with the walking and biking paths opening to the parking.



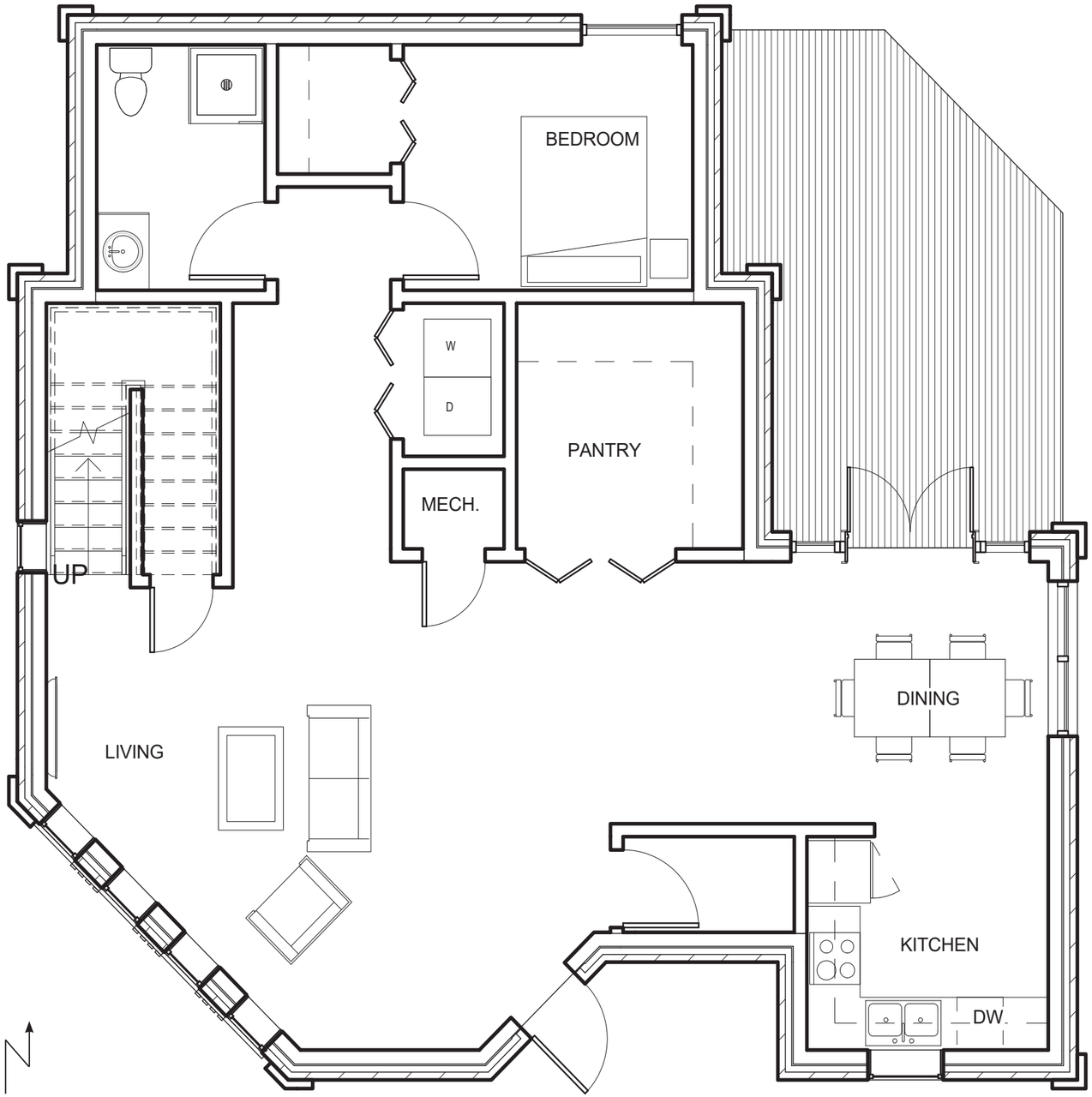


North-West Corner of the site

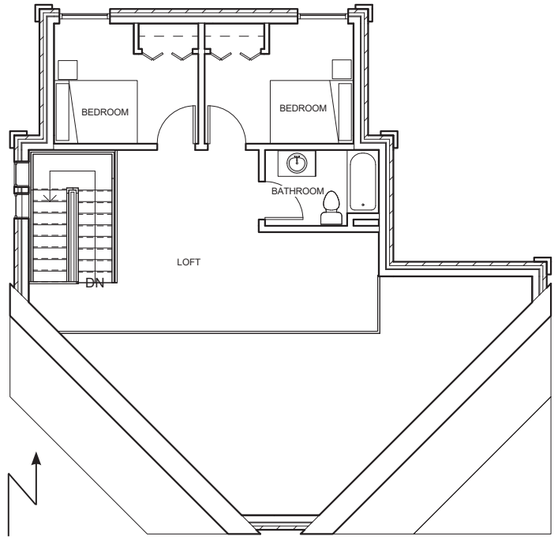
# Nature's Net Positive: Design Thesis

The floor plans were designed so that the private spaces are on the North side of the home while the open and public spaces are on the South. The homes are entered from two locations. If the home is on the North side of the sidewalk the home is entered from the doors by the dining and kitchen. If the home is on the South side of the sidewalk the home is entered through the door by the living room. The social spaces in the home are open and get most of the day light from the double skin roof. The living room, kitchen, and dining areas are directly under the roof with no floor over top. The bedrooms have a window that spans from floor to ceiling and connects to a wall so that light is filtered in off the three surfaces. This window acts like a cave entrance with the sunlight coming in from this one location. There is also window that follow up the stairs as well as a set of windows that face south located in the living room.

The second floor is set over the North half of the building. The staircase opens up to a loft that overlooks the living room, kitchen, and dining room. The bedrooms are set on the north wall with the same window system as the first floor.



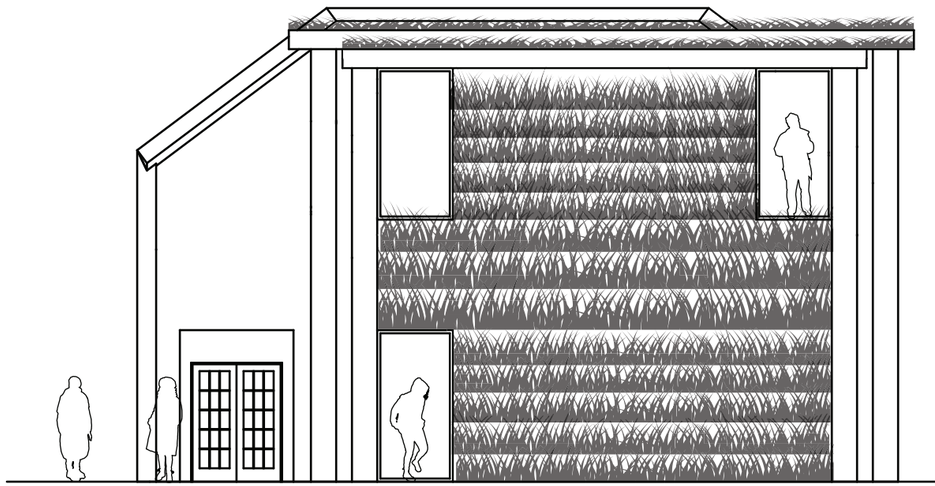

First Floor Plan



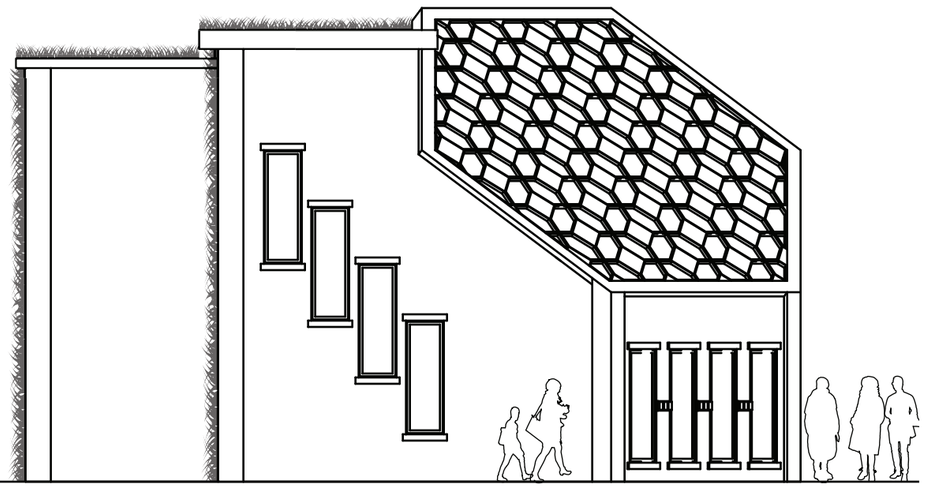

Second Floor Plan

# Nature's Net Positive: Design Thesis

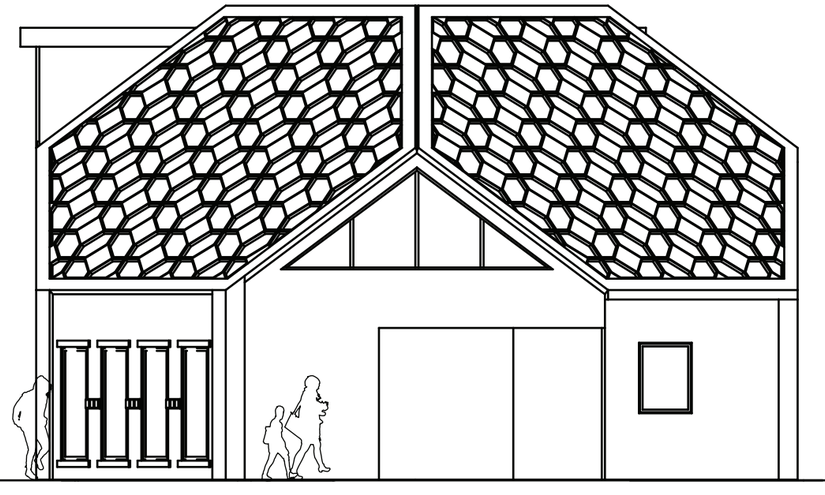
The facade is concrete paneling with a green wall and green roof system on the North-facing sides of the homes. The facade was designed to support and elevate the importance of the roof. The roof is the main feature of the homes and is celebrated as such. There is minimal facade detailing and edge features as to help celebrate the importance of the roof.



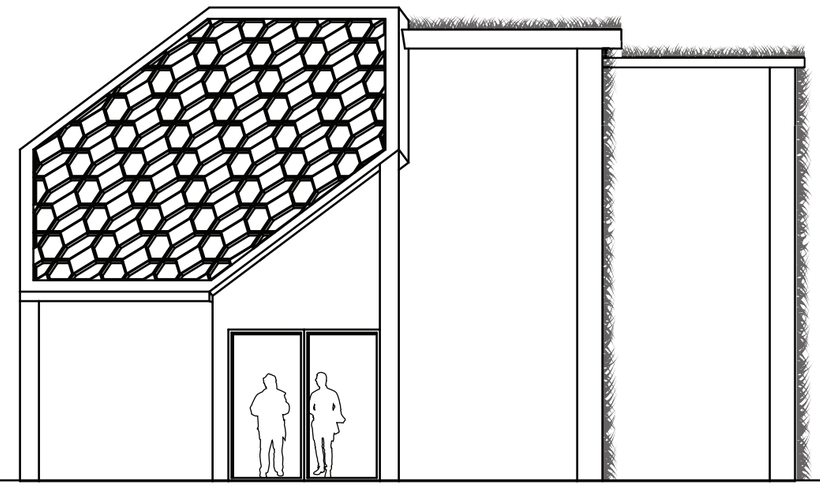
North Elevation



West Elevation



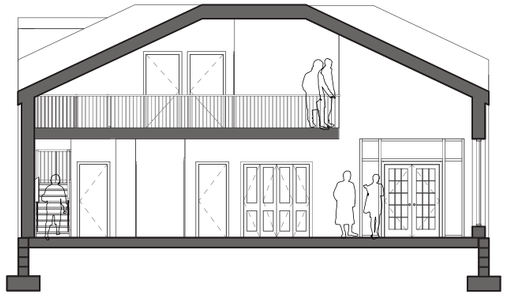
South Elevation



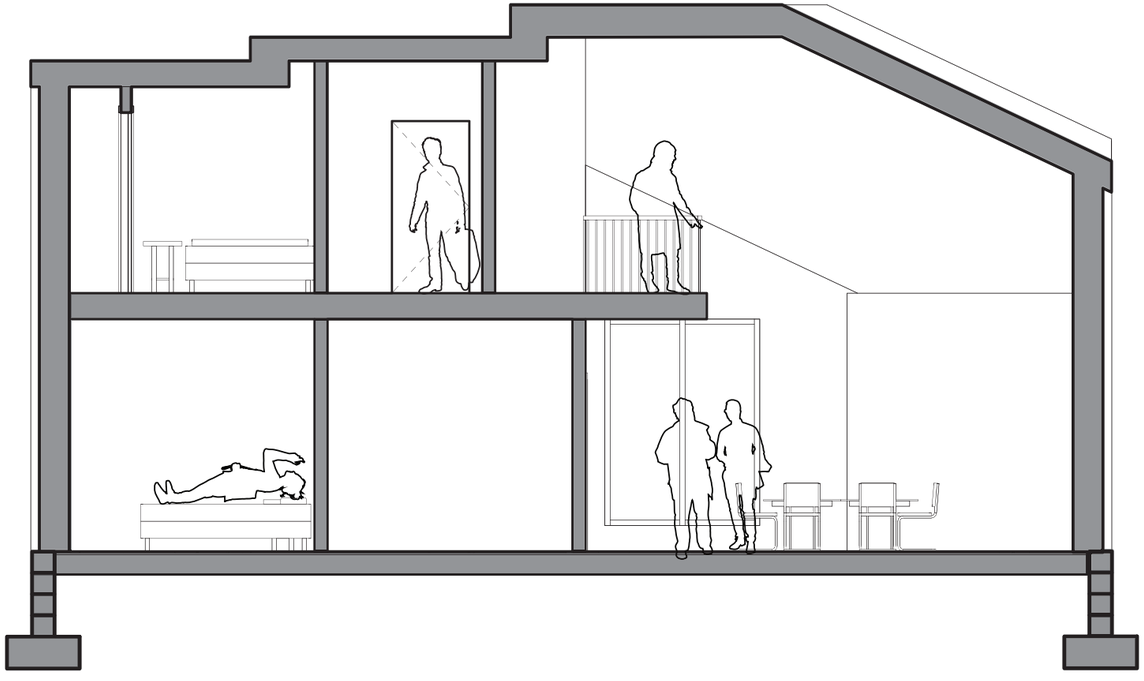
East Elevation

# Nature's Net Positive: Design Thesis

The sections help to show the space interactions. The loft overlooks the public spaces and has enough head spaces to work. The sections also begin to show how tall the roof on the South half of the building is. The decision to make the roof tall was made in order to show the importance of light in those spaces. The light funnels down into the spaces through the double skin roof.



East - West Section

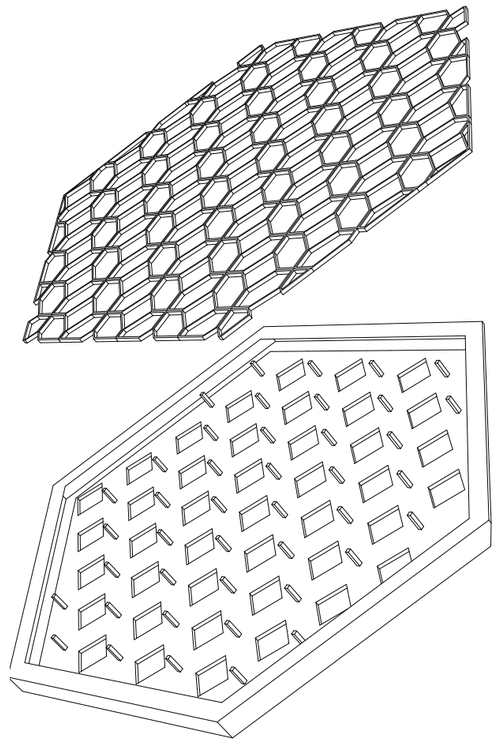


North - South Section

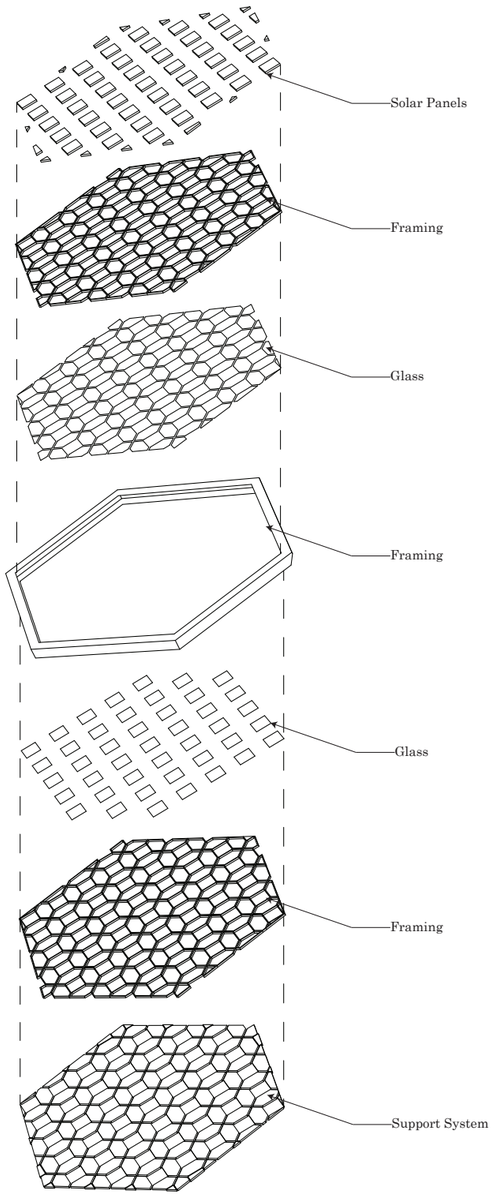


# Nature's Net Positive: Design Thesis

The double skin roof is made of seven parts. The seven parts are split into two halves the top halve consists of solar panels, a framing system, and glass. The bottom halve is glass, framing, and structural system to support the roof. The two halves are connected by the main framing and there are support pieces between the two framings. The opaque and transparent surfaces switch places on the bottom and top halves.

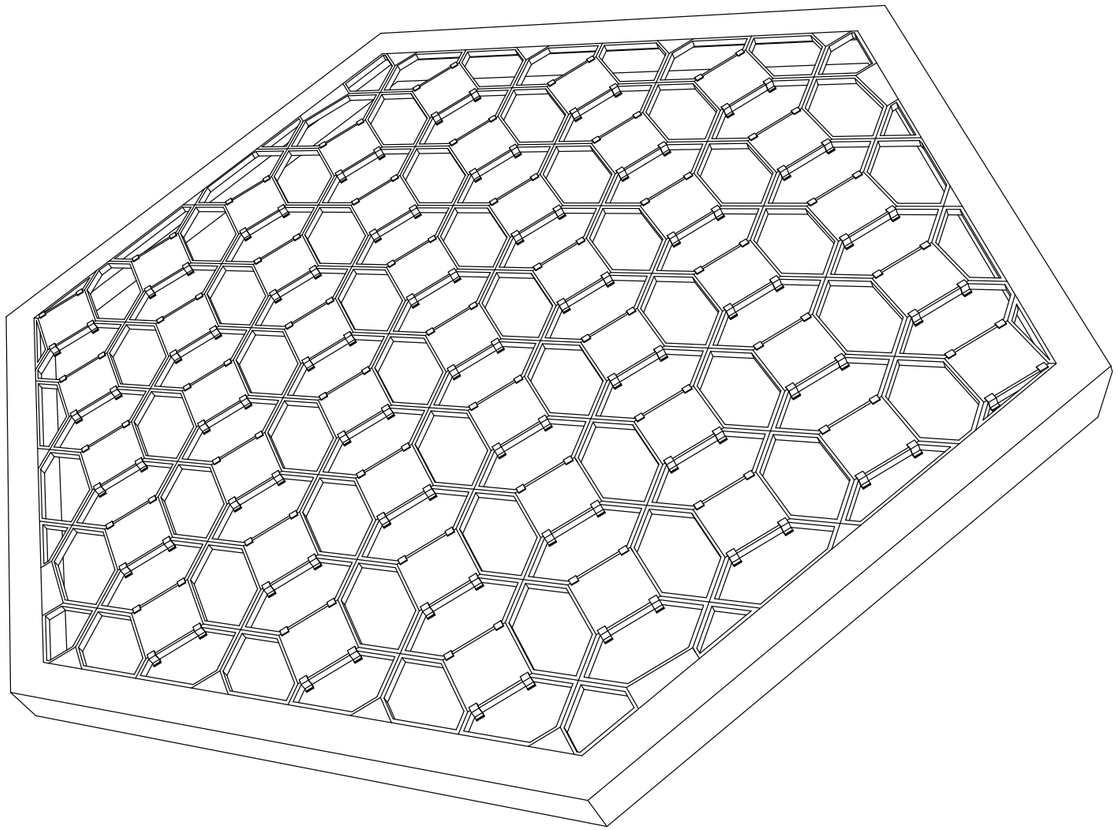


Framing Support




Double Skin Roof

The solar panels are attached to the roof by clipping to the frame. There are 43 solar panels on each of the double skin roofs and 86 solar panels total for each home. The glass and framing are then placed in the opening left.

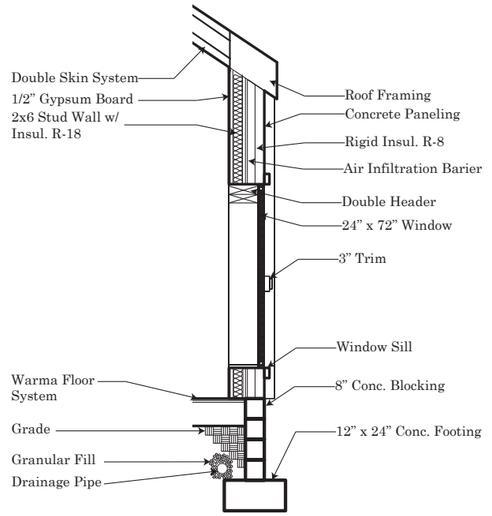


Solar Panel Clipping





The North Facing wall will be a green roof and green wall system to add to the carbon sink as well as providing beauty around the site. The clip in system for the green wall allows for change through the season for the homes. The wall section is a 2x6 stud wall system.




Wall Section

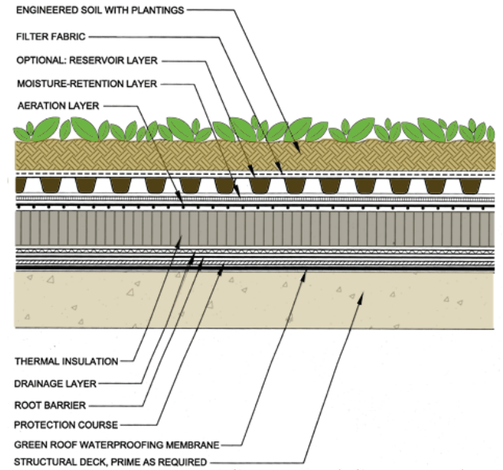



Image 54: Extensive Green Roof Structure from Brooks-Church.

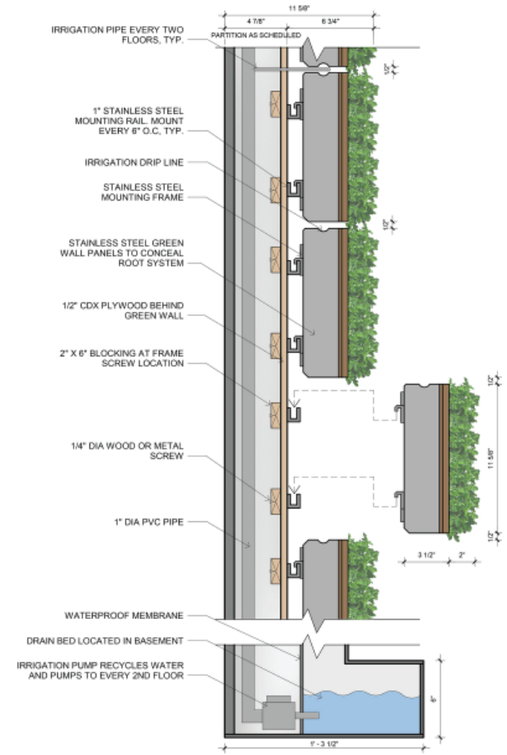
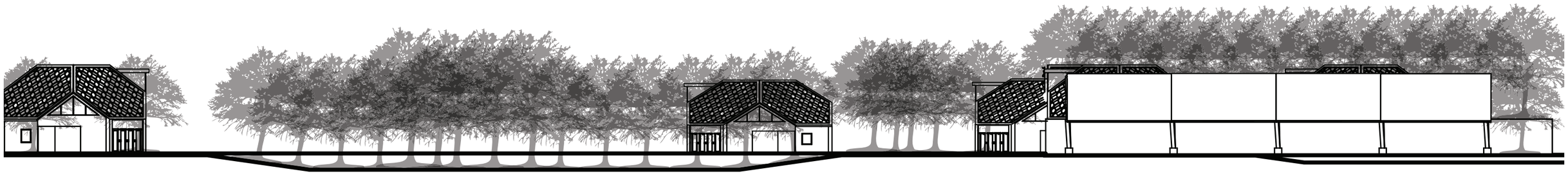



Image 55: Wall Section with green wall system by Bridget Sax.

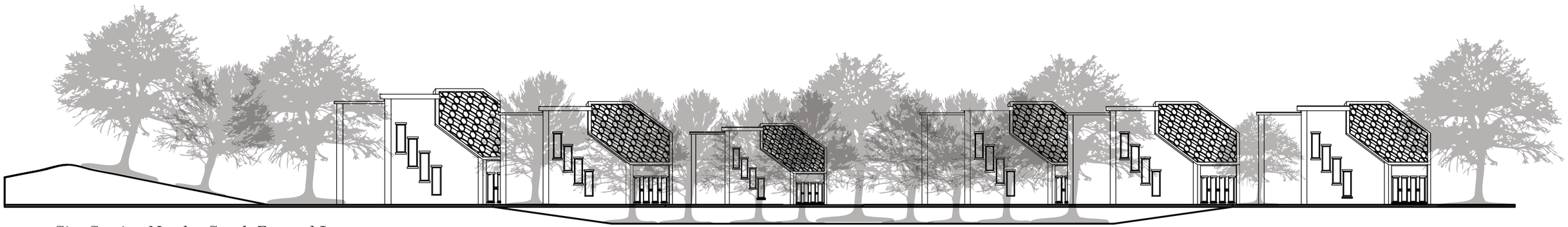
## Nature's Net Positive: Design Thesis

The mini forest and raingardens are lower to allow the rainwater on site to flow and collect in these spaces rather than random spots on the site. The hills and trees help to hide the parking in the center of the site. The parking is covered by pv panels for shade and to assist with energy collection. The parking also alternates between north and south sides of the parking area.

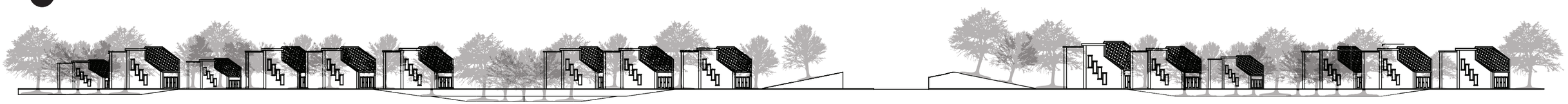


Site Section East - West Zoomed In

Site Section East - West



Site Section North - South Zoomed In



Site Section North - South

# Nature's Net Positive: Design Thesis

For solar panel calculations, Nature's Net Positive is using a 250-watt solar panel and gets around 5 hours of sunlight per day.

- 250 watts x 5 hours x .75 = 937.5 daily watt hours

- 937.5 / 1000 = 0.937

So, this thesis gets around 0.94 KWh of energy per solar panel

There are 84 solar panels per home. Therefore, each home produces 78.96 KWh of energy. Assuming a home, around the size of the homes in this these, uses 900 KWh per month or 30 KWh per day. Each home would be able to offset the energy consumption.

Now assuming each solar panels only gets 2-3 hours of sunlight on a day. This would provide 375-562.5 watt hours. This provides 0.38-0.56 KWh which means each home is producing 31.92-47.04 KWh. This means even on days with less sunlight the homes produce enough energy to offset energy consumption.

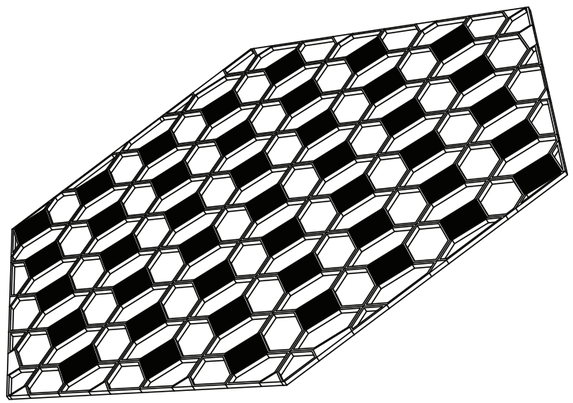


Image 56: Solar panels on roof by author.

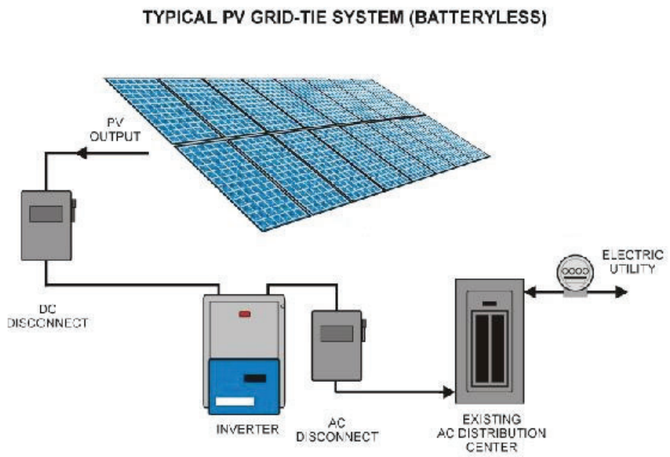



Image 57: Typical PV Grid-Tie System from Solar Energy Illinois.



Nature's Net Positive: Design Thesis

The ECS layout for this thesis is a central mechanical room and filters through the home. The heating and cooling system is built into the floor so that air flows up and through the homes. With the heating and cooling built into the floor the air can flow up and work alongside the double skin roof which collects and release heat. The double skin system collects heat and release heat when too much is collected. The collected heat is used to assist in heating the systems. These systems work together to keep the homes at a comfortable temperature.

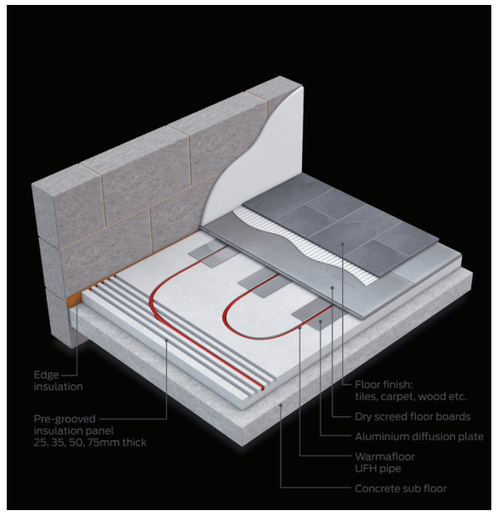



Image 58: "Underfloor Heating and Cooling Systems." by Warmafloor.

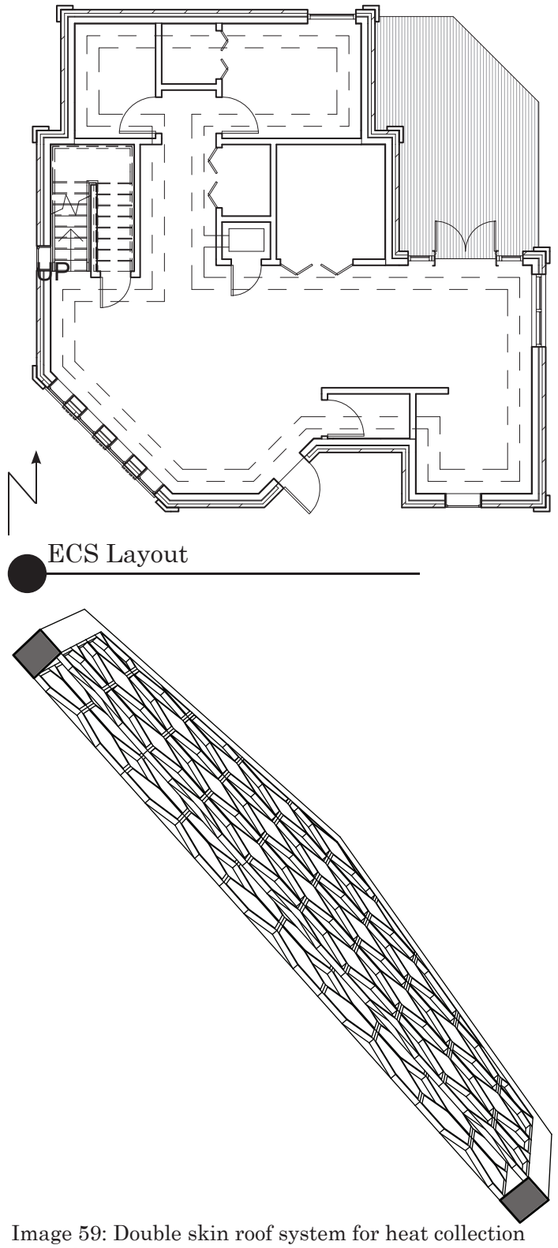



Image 59: Double skin roof system for heat collection by author.

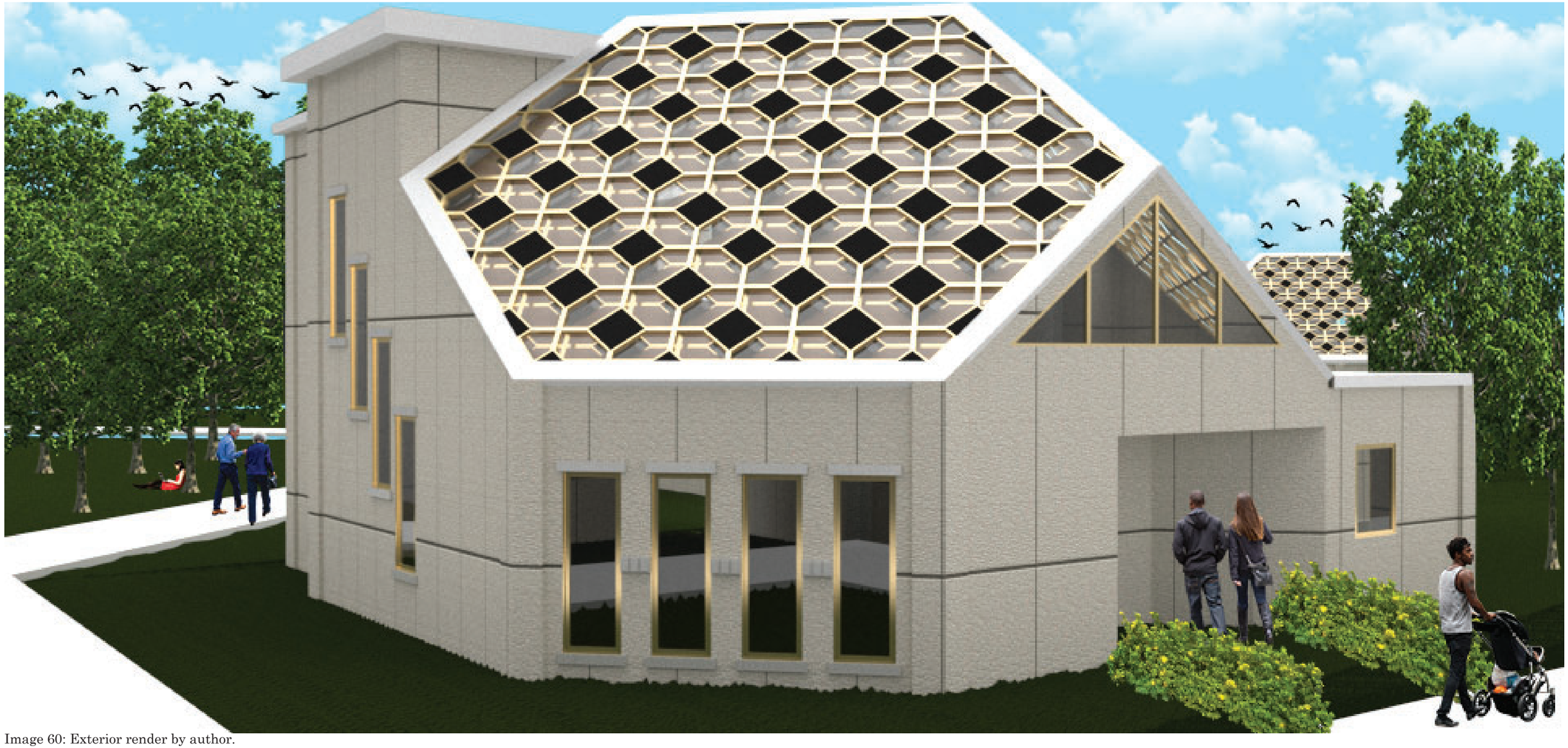


Image 60: Exterior render by author.

## Nature's Net Positive: Design Thesis

The parking runs through the center of the site. The ground is rasied and miny forest are built up on the hills to hide the parking in the middle of the site from the homes. The walk ways open up to the parking once you walk through the cuts in the hills. The parking alternates from one side to the other. There are also solar covers over the parking spaces to provide shade and extra energy for the site.

Image 61: Render of hidden parking by author.

Image 62: Exterior render by author.

## Nature's Net Positive: Design Thesis

The living room is open with good sun lighting that is not overbearing. The flooring is tile to allow for the heating and cooling systems built into the floor to work better.

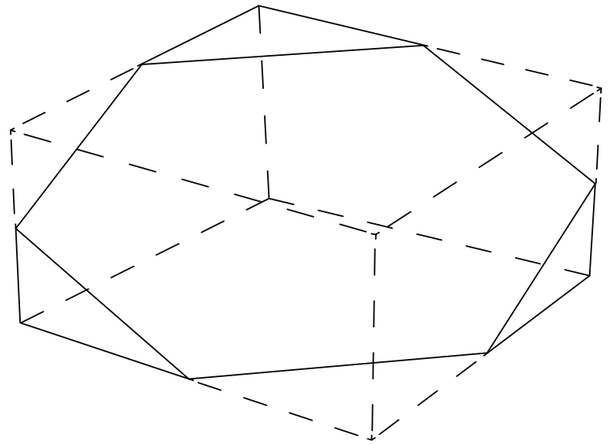
Image 63: Living room render by author.

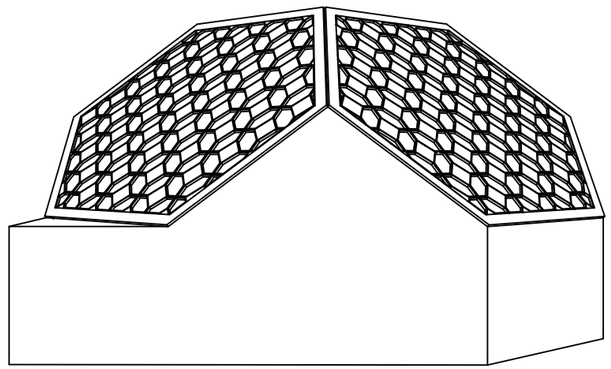


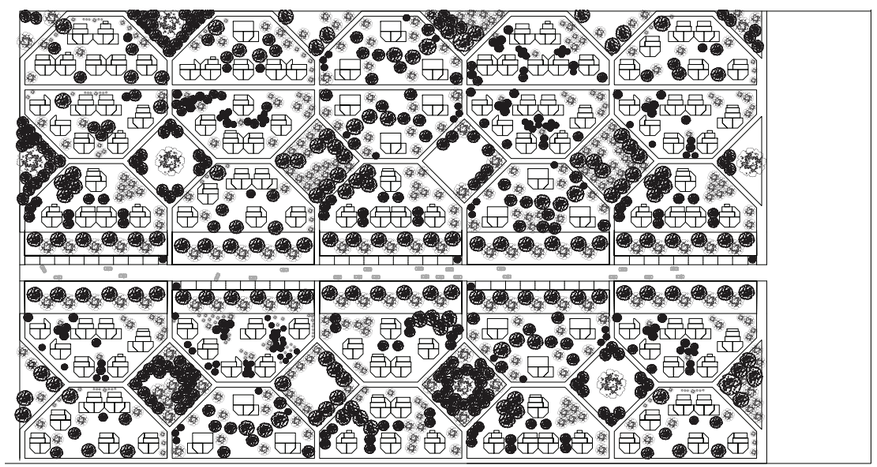
Nature's Net Positive: Design Thesis

**Integrating Decisions**

Each idea was explored along side the other explorations. The allowed for the systems and layouts to grow and change along side the other explorations so that everything can come together as a set of systems. The double skin system lets in lighting without flooding the rooms with light. The passive systems along side the active systems will help to achieve the goal of net positive in energy, water, and heat. Each idea works together in a way that pushes the design futher along as a set of systems rather than each piece being alone on the site.



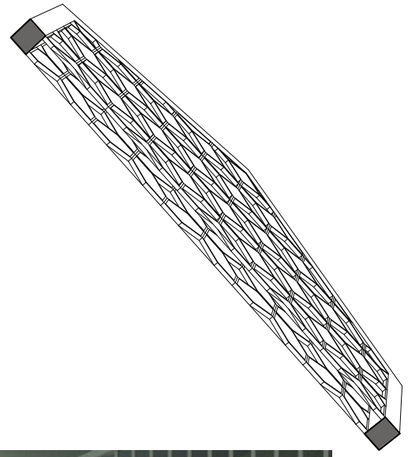




# Nature's Net Positive: Design Thesis

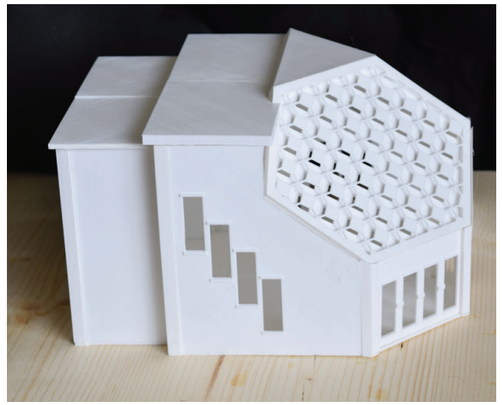
**Predicting Effectiveness**

The layout of the site and skin system chosen to create the lighting experience that was set to be created. This thesis achieves the goal of exploring lighting at three different scales each with a different effect being created. This thesis also achieved the goal of being net positive. The energy produced should outway the energy consumed. Even on days with less sunlight the energy should at least offset energy consumed because of the reduced need to light certain spaces during parts of the day.





# Nature's Net Positive: Design Thesis-Physical Model



## Conclusion

This thesis began with the study of sunlight and past architectural designs. Sunlight is an important aspect of architecture and should be included throughout the design process. Allowing for daylight to enter into the building provides more than light, it provides health benefits and an opportunity to conserve energy. Studies have shown that sunlight is beneficial for the human race. Failing to incorporate natural light into a design can be detrimental to the design. This thesis was created to celebrate sunlight and to use it as an integral part of the design to create a net positive small housing community.

Nature's Net Positive has explored lighting at three different scales. These lighting experiences work alongside the passive and active systems to allow for a net positive community. The lighting experiences in the homes serve a purpose beyond providing light; they lower energy requirements and overall energy consumption in the homes as well. The control of lighting entering the homes allows for increased use of sun lighting as opposed to electrical lighting. This allows for an average of 30 KWh of energy to be used in the homes. On days with only 2 hours of day light 31.92 KWh of energy are still produced. The slope of the roof was also designed to prevent snow build-up during winter maintaining the lighting experiences as well as energy production.

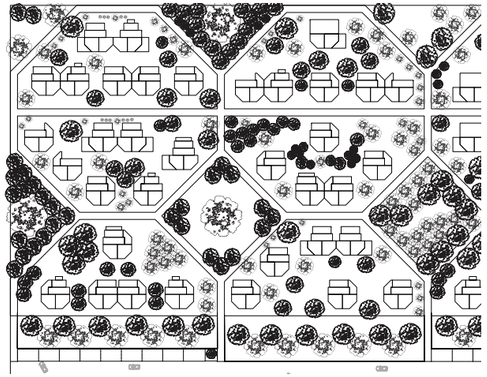
The community is an experience that can be explored with light and darker spaces spread throughout the site. The site also serves as a carbon sink with trees creating light and dark spaces while preserving the environment. Parking spaces allow for energy production via the solar shading structure. This design further offsets the energy production against the energy consumption throughout the community. With the energy production alongside water and heat collection systems this thesis creates a net positive solution which allows for ease of systems working together toward the same goals. Rather than each piece working individually the parts come together as a set of systems which goes above and beyond the required.

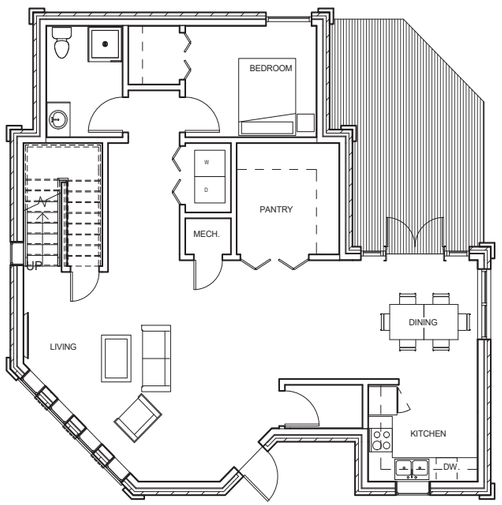
This thesis began as an exploration of net positive communities focused on lighting experience to lower energy consumption. Not only does this thesis achieve the goal of sunlight to lower energy consumption, it further explores the ideas of water and energy conservation within a community setting. Nature's Net Positive unites the past with the future by incorporating the community's historical farming background with innovative designs to maximize the use of daylighting. The mini forest and rain gardens provide inviting greenspaces for residents to relax while at the same time serving as water



## Reflection

Nature's Net Positive is an exploration of light at site, building, and room scale. The explorations made allowed each idea to further evolve. Each idea was a spinoff of previous ideas all coming together towards the end goal. The overarching form of the project was the first decision made. This form evolved and the iterations became skins and layouts for the other aspects of the project. Early groupings for the massing became ideas that allowed for the skin systems and site to fit into an overarching set of systems all following the original form. Each component is similar to the original groupings. Four of the massing put together created a pattern which was replicated and applied where needed. These were then altered to work alongside the component it was placed onto. This was important because to allow the ideas to move forward continually adding to the other systems. Each plan was carefully examined to ensure it would work alongside the other plans creating a community that flowed together in the end.





Bibliography


“Accessibility Progress Slow at Queen’s.” The Journal. Accessed December 6, 2019. https://www.queensjournal.ca/story/2015-03-20/features/accessibility-progress-slow-queens/.

Chepchumba, Nyole F, 2013.“History of Daylighting Strategies: A Comparative Analysis .”

CSC Design Studio :: Architecture Projects. Accessed November 15, 2019. http://www.cscdesignstudio.com/project_arc_gallery.html.

“Daylighting and Architecture: How Classic Historical Buildings Used Daylighting.” Bristolite Daylighting Systems - Leading Skylight Manufacturer in USA, March 12, 2014. http://www.bristolite.com/blog/daylighting-and-architecture-how-classic-historical-buildings-used-daylighting/.

“Extensive Green Roof: Gennaro Brooks.” Church, May 28, 2010. https://brookschurch.com/extensive-green-roof/.

“House, No. 5, Element House.” MOS. Accessed January 20, 2020. https://www.mos.nyc/project/element-house.

“Landezine Newsletter.” Landezine. Accessed January 20, 2020. http://landezine.com/index.php/2009/07/aerial-suburbia-drawings/.

Lowy, Allie. “Keep Forests as Forests: the Importance of Forests as Carbon Sinks.” Medium. The Climate Series, July 19, 2018. https://medium.com/the-climate-series/keep-forests-as-forests-the-importance-of-forests-as-carbon-sinks-63b7d2bde3bb.

“Luciano Pia Plants 25 Verde, a Green Urban Treehouse in Torino.” designboom, February 22,2016. https://www.designboom.com/architecture/luciano-pia-25-verde-treehouse-torino-italy-03-13-2015/.

“Rainwater Harvesting Systems vs Rain Barrels - Chicagoland & Kane County Illinois (IL).” Ponds Inc. Accessed December 1, 2019. https://www.ponds-inc.com/rain-barrel-or-rainwater-harvesting.html.

Richard Waite. “BSF Funding Should Not Be Cut, Says CABE.” Architects Journal. 26 February, 2010. Accessed March 13, 2020. https://www.architectsjournal.co.uk/home/bsf-funding-should-not-be-cut-says-cabe/5214800.article.

Sax, Bridget. “Capstone_Women’s Wellness and Birth Center_Spring 2018.” Capstone_Women’s Wellness and Birth Center_Spring 2018 on PhilaU Portfolios. Accessed March 17, 2020. http://designportfolios.philau.edu/gallery/65105943/Capstone_Womens-Wellness-and-Birth-Center_Spring-2018.

“Solar Energy of Illinois.” Grid-Tied - Solar Energy of Illinois. Accessed March 17, 2020. https://www.solarenergyofillinois.com/grid-tied.

Spranz Henrik. “Sunshine Forest: The Light Through The Trees Photo Contest Winners.” ViewBug.com. Accessed November 8, 2019. https://www.viewbug.com/blog/the-light-through-the-trees-photo-contest-winners.

Taylor, Glenda. “Loamy Soil 101: How to Make and Garden with It.” Bob Vila. Bobvila.com, May 9, 2018. https://www.bobvila.com/articles/loamy-soil/.

“Torr Kaelan Creates Physical and Elegant Relationship with Street through Its Protruding Facade.” World Architecture Community. World Architecture Community, March 3, 2017. https://worldarchitecture.org/articles/cvhzv/torr_kaelan_creates_physical_and_elegant_relationship_with_street_through_its_protruding_facade.html.

“Underfloor Heating and Cooling Systems.” Warmafloor. Accessed March 15, 2020. https://warmafloor.co.uk/.




Image 1: Henrik, Spranz, “Sunshine Forest: The Light Through The Trees Photo Contest Winners,” ViewBug.com, Accessed November 8, 2019, https://www.viewbug.com/blog/the-light-through-the-trees-photo-contest-winners.

Image 2: “Accessibility Progress Slow at Queen’s.” The Journal. Accessed December 6, 2019. https://www.queensjournal.ca/story/2015-03-20/features/accessibility-progress-slow-queens/.

Image 3: 26 February, 2010 By Richard Waite. “BSF Funding Should Not Be Cut, Says CABE.” Architects Journal. Accessed March 13, 2020. https://www.architectsjournal.co.uk/home/bsf-funding-should-not-be-cut-says-cabe/5214800.article.

Image 4: Lowy, Allie. “Keep Forests as Forests: the Importance of Forests as Carbon Sinks.” Medium. The Climate Series, July 19, 2018. https://medium.com/the-climate-series/keep-forests-as-forests-the-importance-of-forests-as-carbon-sinks-63b7d2bde3bb.

Image 5: Author

Image 6: Taylor, Glenda. “Loamy Soil 101: How to Make and Garden with It.” Bob Vila. Bobvila.com, May 9, 2018. https://www.bobvila.com/articles/loamy-soil/.

Image 7: Author

Image 8: Author

Image 9: Author

Image 10: Author

Image 11: Author

Image 12: “Luciano Pia Plants 25 Verde, a Green Urban Treehouse in Torino.” designboom, February 22,2016. https://www.designboom.com/architecture/luciano-pia-25-verde-treehouse-torino-italy-03-13-2015/.

Image 13: “Torr Kaelan Creates Physical and Elegant Relationship with Street through Its Protruding Facade.” World Architecture Community. World Architecture Community, March 3, 2017. https://worldarchitecture.org/articles/cvhzv/torr_kaelan_creates_physical_and_elegant_relationship_with_street_through_its_protruding_facade.html.

Image 14: CSC Design Studio :: Architecture Projects. Accessed November 15, 2019. http://www.cscdesignstudio.com/project_arc_gallery.html.

Image 15: “House, No. 5, Element House.” MOS. Accessed January 20, 2020. https://www.mos.nyc/project/element-house.

Image 16: “Landezine Newsletter.” Landezine. Accessed January 20, 2020. http://landezine.com/index.php/2009/07/aerial-suburbia-drawings/.

Image 17: Author

Image 18: Author

Image 19: Author

Image 20: Author

Image 21: Author

Image 22: Author

Image 23: Author

Image 24: Author

Image 25: Author

Image 26: Author

Image 27: Author

Image 28: Author

Image 29: Author

Image 30: “Underfloor Heating and Cooling Systems.” Warmafloor. Accessed March 15, 2020. https://warmafloor.co.uk/.

Image 31: “Rainwater Harvesting Systems vs Rain Barrels - Chicagoland & Kane County Illinois (IL).” Ponds Inc. Accessed December 1, 2019. https://www.ponds-inc.com/rain-barrel-or-rainwater-harvesting.html.

Image 32: “Rainwater Harvesting Systems vs Rain Barrels - Chicagoland & Kane County Illinois (IL).”

Image 33: Author

Image 34: Author

Image 35: Author

Image 36: Author

Image 37: Author

Image 38: Author

Image 39: Author

Image 40: Author

Image 41: CSC Design Studio :: Architecture Projects. Accessed November 15, 2019. http://www.cscdesignstudio.com/project_arc_gallery.html.

Image 42: Author

Image 43: Author

Image 44: “House, No. 5, Element House.” MOS. Accessed January 20, 2020. https://www.mos.nyc/project/element-house.

Image 45: Author

Image 46: “Landezine Newsletter.” Landezine. Accessed January 20, 2020. http://landezine.com/index.php/2009/07/aerial-suburbia-drawings/.

Image 47: Author

Image 48: Author

Image 49: Author

Image 50: Author

Image 51: Author

Image 52: Author

Image 53: Author

Image 54: “Extensive Green Roof: Gennaro Brooks.” Church, May 28, 2010. https://brookschurch.com/extensive-green-roof/.

Image 55: Sax, Bridget. “Capstone_Women’s Wellness and Birth Center_Spring 2018.” Capstone_Women’s Wellness and Birth Center_Spring 2018 on PhilaU Portfolios. Accessed March 17, 2020. http://designportfolios.philau.edu/gallery/65105943/Capstone_Womens-Wellness-and-Birth-Center_Spring-2018.

Image 56: Author

Image 57: “Solar Energy of Illinois.” Grid-Tied - Solar Energy of Illinois. Accessed March 17, 2020. https://www.solarenergyofillinois.com/grid-tied.

Image 58: “Underfloor Heating and Cooling Systems.” Warmafloor. Accessed March 15, 2020. https://warmafloor.co.uk/.

Image 59: Author

Image 60: Author

Image 61: Author

Image 62: Author

Image 63: Author